Elletin 215 August, 1926

Agricultural Experiment Station

College of Agriculture, West Virginia University

HENRY G. KNIGHT, Director
Morgantown

Lime For West Virginia Farms

Pulverizing Limestone on the Farm

By

D R. DODD

Fig. 1.—Worn and Unproductive Clay Soil.

TABLE 1.—Yields of Corn, Wheat and Mixed Hay With and Wit-out Lime at the Maggie Sub-Station in 1925.

Treatment	Yield in Bushels or Tons		
	Corn (bu)	Wheat (bu)	Hay (tons)
Lime*	67.0	22.0	2.32
No Lime	60.1	18.3	1.85

*Lime was applied at the rate of two tons of ground limestone per acre.

An experiment conducted at the Ohio Agricultural Experime Station, gave results so closely in accord with West Virginia resul that attention is here called to it.* The experiment was begun 1900 and is still in progress. The crop rotation used is corn, oat wheat, clover, and timothy. Table 2 gives the yields on both t limed and unlimed areas and the gain for lime. The application lime has been the equivalent of two tons of ground limestone p acre for each rotation or every five years. The data given are f the five year period from 1914 to 1918 inclusive. Using a value $1.00 for corn, $0.50 for oats, $1.50 for wheat per bushel, and $20.0 a ton for hay, a return of $16.00 for the equivalent of each to of ground limestone used is obtained. Practice has shown th West Virginia farmers may expect similar results.

*Ohio Agricultural Experiment Station, Wooster, Ohio, Bulletin 336.

Fig. 2.—Soil Adjoining That Shown in Figure 1 and Formerly in the Same Worn Out Condition. A Bumper Crop of Sweet Clover Is the Result of Proper Applications of Lime and Acid Phosphate.

Will Lime Take the Place of Fertilizer

A good many farmers hold the impression that where lime is used an application of fertilizer is not necessary. This is wrong. Lime is not a direct fertilizer and is seldom needed as a plant nutrient, there being an abundance of lime in the soil for this purpose. Lime has a tendency to sweeten the soil, improve its mechanical condition, and make it a more favorable medium for the development of bacteria.

The operation of these factors increases chemical action rendering plant foods more available. However, they cannot increase the total supply of mineral element in the soil. Maximum yields cannot be obtained from the use of lime alone. This point is well shown in the Ohio experiment just referred to and summarized in Table 2. One series of plots received no treatment, another series received lime only, and a third series received both lime and fertilizer. The third horizontal line in Table 2 gives the yield for lime and fertilizer, and the fifth line gives the gain for fertilizer when used on limed land.

From Table 2 it is evident that lime pays even on unfertilized land but as shown by the figures at the bottom, maximum returns cannot be obtained without the application of fertilizer in some form in addition to lime.

TABLE 2.—Average Yield per Acre of Various Crops Under Different Treatments as Obtained at the Ohio Agricultural Experiment Station, Wooster, Ohio.

Treatment	Yield in Bushels or Pounds				
	Corn Bushels	Oats Bushels	Wheat Bushels	Clover Pounds	Timothy Pounds
Untreated	21.45	35.24	11.67	638	1339
Lime only	28.03	45.28	16.96	1338	2194
Lime and fertilizer	45.95	58.46	29.84	2297	2865
Gain for lime only	6.58	10.04	5.29	700	855
Gain for fertilizer over lime alone	17.92	13.18	12.88	959	671

Lime on Pasture Land

With the increase in land values, taxes, labor costs, fence costs, and miscellaneous expenses, and in many cases, the decrease in the carrying capacity of pastures, West Virginia farmers since 1900 have been rapidly approaching that point when the pastures no longer pay any profit. During recent years many farmers have seen this and have taken steps to improve their pastures and thereby increase their returns.

In 1910 Mr. C. C. Lewis of Point Pleasant, West Virginia, started an experiment in pasture improvement. One-half of a pasture adjoining the highway was limed with one ton of burned lime per acre. Today, sixteen years after the application, anyone passing the field during the growing season can readily see the line marking the extent of the lime. The carrying capacity of the limed area was increased by 50 per cent or more and remained so for at least ten years. The difference is less evident today, but there is no doubt that each dollar invested in lime on this pasture has given excellent returns.

In 1923 an experiment was begun at the West Virginia Agricultural Experiment Station at Morgantown, one of the objects of which was to determine what increase might be expected from the use of lime on pasture land. The experiment is still in progress.

The land used for this experiment is a sandy loam hillside of the Dekalb series. It was so poor as to be practically worthless. This is shown by the fact that the untreated check plots produced only 429 pounds of dry grass per acre. These figures are probably

little low due to the fact that the grass was mown. Stock might ave nipped it a little closer. Where lime was used the yield was 23 pounds and where lime and acid phosphate were used the yield ,as 993 pounds per acre. This represents an increase of 68 per cent or lime alone and 131 per cent for lime and acid phosphate. Both he lime and acid phosphate were harrowed in lightly. Returns were ot so good where harrowing was omitted. This was especially rue for the acid phosphate. These and other tests and experiments eave little room for doubt concerning the general advisability of pplying lime to many of our pastures, especially in connection with cid phosphate.

Kinds of Lime to Use

All liming material does not have the same neutralizing power; hat is, 1120 pounds of freshly burned lime will neutralize as much oil acid as 2000 pounds of ground limestone. Liming recommenda- ions are generally made in terms of ground limestone. The amounts f other materials which might be used in the place of 2000 pounds f ground limestone are:

Burned lime—1120 pounds
Hydrated lime—1480 pounds
Air slaked lime—2000 pounds
Marl (dry)—2000 pounds
Marl (freshly dug or wet)—2500-3000 pounds
Oyster shells (ground)—2000 pounds
Wood ashes—2700-3500 pounds

The more finely limestone is ground the more quickly will it ieutralize an acid soil. Experiments indicate that for best results imestone should be of such fineness that 95 to 100 per cent of it will ass through a screen with ten meshes to the inch and 40 per cent hrough a screen with a hundred meshes to the inch.

All forms of lime should be bought on the basis of a guarantee f purity which is usually indicated by the sum of the percentages f calcium and magnesium oxides. To compare prices on two or nore kinds of lime, divide the price per ton plus the cost of hauling y the percentage of total oxides. This gives the delivered cost per unit (1 per cent or 20 pounds) of oxide. The purity of raw or ground imestone and marl is frequently stated as percentages of calcium and nagnesium carbonates. In this case it is necessary first to express he total percentage of these carbonates as the total percentage of

the corresponding oxides by multiplying by 0.56, before dividing the price per ton by the total percentage, in order to compare the prices of these materials with burned or hydrated lime.

For example let us suppose materials to cost per ton delivered at the farm as follows:

Ground Limestone		$6.00
	40 per cent magnesium carbonate	
	55 per cent calcium carbonate	
	95 per cent total carbonates	
Hydrated Lime		$12.00
	70 per cent total oxides	
Freshly Burned Unslaked Lime		$9.00
	90 per cent total oxides	

In the case of ground limestone: 95 times .56 equals 53.2 per cent total oxides, $6.00 divided by 53.2 equals 11.2 cents cost per unit.

In the case of hydrated lime: $12.00 divided by 70 equals 1[illegible] cents cost per unit.

In the case of freshly burned lime: $9.00 divided by 90 equals 10 cents cost per unit.

On the basis of these assumed or arbitrary costs it appears that freshly burned lime is the cheapest. This may not be true in some cases in dealing with actual costs. One should also consider the agreeableness of handling. Freshly burned lime is of course objectionable in this respect. In the case of ground limestone and marl a guarantee of fineness should be required and taken into consideration in comparing different materials.

How much lime per acre? The answer to this question depends upon the acidity of the soil, the crops to be grown, and the cost of the lime. West Virginia soils vary in the amounts of lime needed from none to five or six tons of ground limestone per acre. Before investing in lime have a sample of your soil tested by your county agent.

Crops differ in their response to liming. The increases in per cent over the unlimed plots for the crops grown in the West Virginia and Ohio experiments previously mentioned have been as follows: clover 46, timothy 38, wheat 20, corn 18, and oats 12. Alfalfa needs more lime than red clover, while soybeans do reasonably well on soils

Amounts to Use

which are too sour to grow clover. For the general farm where it is desired to grow clover and where the cost of lime is not great a first application of two tons of ground limestone or its equivalent per acre with later applications of one ton every six years is about right for the average West Virginia soil. As a rule the first thousand pounds of limestone applied gives a larger net return than the second thousand pounds, the second gives more than the third, and so on. In many cases applications of a thousand pounds of ground limestone have brought good clover where none grew before. Where the cost of getting lime to the farm is excessive, small applications should be the rule. After the response to lime has been determined, larger applications may be made if desired.

Maximum returns, however, cannot be expected unless liming be made a definite part of the soil improvement program, and lime be applied as needed in connection with the use of organic matter and fertilizer in a good rotation.

There are some locations in West Virginia where ground limestone, refuse lime, or marl, may be obtained at a low cost. In such cases larger applications than those recommended above may be used.

On pasture land best returns are generally obtained when the application of lime is at the rate of about two tons of ground limestone or its equivalent per acre, together with three hundred pounds of acid phosphate. This is best "harrowed in" lightly where conditions permit, but may be used as a top dressing and left to incorporate itself. Where the stand of grass is not good it is advisable to reseed before harrowing with a good pasture mixture such as ten pounds Blue grass, five pounds Orchard grass, three pounds Red top, two pounds Japan clover, and two pounds White Dutch clover.

When and How to Apply

Probably the best time to apply lime on crop land is when one has time to apply it and the condition of roads and fields make hauling easiest. This is generally after harvest on sod lands. However, where light applications are being made or where lime is being used for the first time better results may be obtained by putting the lime on plowed ground before harrowing. Thus the lime may

Fig. 3.—Clover Demonstration on Farm of Jesse Bean, Hardy Count This Plot Received no Lime.

be more thoroughly incorporated in the soil. Suitable times for suc applications are in the fall before seeding winter grain and in th spring before corn is planted.

On pastures early spring applications give good results.

The use of a spreader, preferably one of the forced-feed type the easiest and best method of spreading most forms of lime. The is also a spreader that may be attached to the rear of the ordinar farm wagon that some farmers like especially for refuse lime whic does not feed well through the ordinary forced-feed type. Limeston marl, and refuse lime, are frequently spread with a manure sprea er. This is easily accomplished by first putting on the bed of th spreader a layer of straw or manure.

Unground burned lime (lump or stone lime) is preferably place in piles in the field to slake and then spread with a shovel. O bushel of lime per pile with piles forty feet apart each way wi make an application of one ton per acre.

It is customary with this practice to cover the piles with little soil for two or three weeks when the lime will be found have taken on a finely powdered condition and is easy to spread.

Home-made Spreader

There are a number of good spreaders now on the market ar generally it is cheaper in the long run to buy one than to attemp to make one at home. The farmer who is skilled with tools, hov

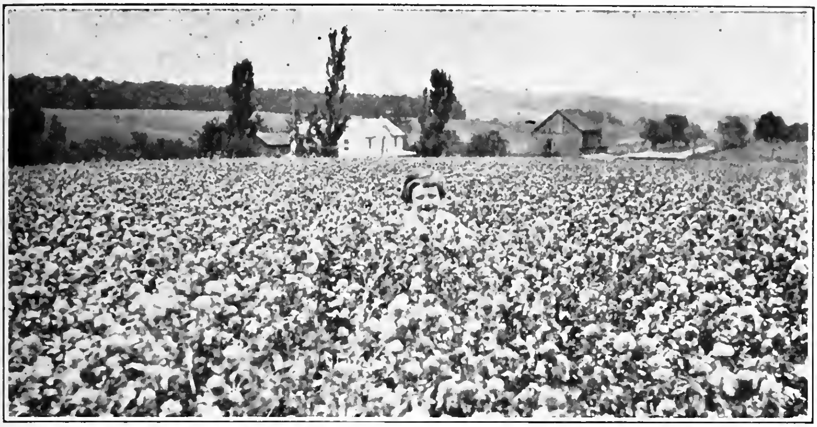

Fig. 4.—This Plot Adjoins that Shown in Figure 3 and Received Ground Limestone at the Rate of Two Tons per Acre. The Girl in This Picture Is on Her Knees.

ever, and is convenient to a blacksmith shop can make a very satisfactory spreader and probably save some money. The following directions are given by Dr. Cyril G. Hopkins (deceased), of the Illinois Agricultural Experiment Station.*

"Make a hopper similar to that of an ordinary grain drill, but measuring 8 1/4 feet long with sides at least 20 inches wide and 20 inches apart at the top. The sides may be trussed with 3/8 inch iron rods running from the bottom at the middle to the top at the ends of the hopper. Let the bottom be 5 inches wide in the clear with 2 inch holes 5 inches between centers. Make a second bottom to slide under the first on straps of iron 10 inches apart, which should be carried from one side to the other under the hopper to strengthen it, also with holes to register. Both bottoms may be of sheet steel or the lower one may be of hard wood, reinforced with strap iron if necessary.

"To the lower and movable bottom attach a V-shaped arm projecting an inch from under the hopper, with a half-inch hole in the point of the V, in which drop the end of a strong lever, bolting the lever loosely but securely to the hopper with a single bolt, and fasten to the top of the hopper a guide of strap iron in which the lever may move to regulate the size of the opening by sliding the lower bottom. Make a strong frame for the hopper, with a strong, well braced tongue.

"Take a pair of old mowing machine wheels of good size, and with strong rachets in the hubs, and fit these to an axle of suitable length (about 10 feet) and 1 3/8 or 1 1/2 inches in diameter. The axle should be fitted with journels bolted to the under side of the frame. Make a reel to work inside the hopper by securing to the axle, 10 inches apart, short arms of 3/8 inch by 3/4 inch iron and fastening to these arms four slats or beaters of 5/8 by 3/4 inch iron about an inch shorter than the inside of the hopper, the reel being so adjusted that the beaters will almost scrape the bottom but will revolve freely between the sides. The diameter of the completed wheel is about 5 inches and it serves as a force feed."

*Cyril G. Hopkins, "Ground Limestone for Southern Soils," page 14.

Commercial Sources of Lime

Generally it is possible for commercial lime companies to produce a cheaper and better liming material than can be made at home. It is, therefore, advisable to first investigate the commercial sources. A list of commercial firms supplying lime to farmers in this state may be had by application to the Agricultural Extension Division, College of Agriculture, Morgantown, West Virginia.

Home Production of Liming Material

Many West Virginia farms are a considerable distance from the railroad. This necessitates a long haul from the railroad to the farm. This long haul, frequently over bad roads, together with freight charges make the cost of commercial lime so high that home production is more advisable. This is, of course, conditioned upon an available supply of good limestone.

The home production of pulverized limestone is more or less common in many sections of the state. A careful checking of all items of expense indicates that the average cost of such production is probably close to $3.00 per ton.

A few years ago the Ohio Experiment Station made some tests in which they were able to produce home pulverized limestone at slightly more than $2.00 a ton. Under present conditions in West Virginia such a low cost is quite the exception.

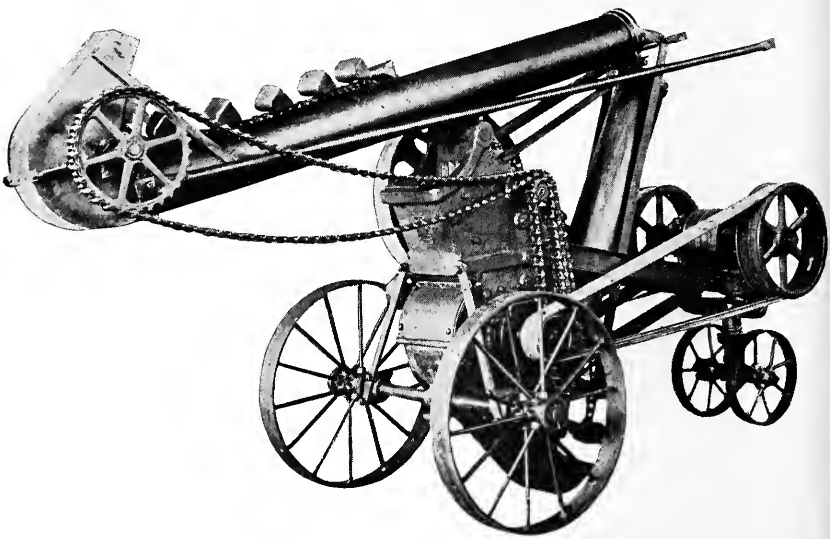

Fig. 5.—A Good Portable Pulverizer for Individual or Community Use. Capacity 15-20 Tons per Day. Power Required 8-16 or 10-20 Tractor.

The home product is generally not quite so good as the com-
ercial product but is very satisfactory and numerous farmers re-
rt excellent results from its use. The chief drawback to home
lverizing is in the cost of equipment and the little use of it during
e greater part of the year. This can be largely overcome by one
an pulverizing for the community or by the community purchasing
d operating the equipment. A list of manufacturers of pulverizing
achinery will be furnished upon application to the Agricultural
xtension Division, College of Agriculture, Morgantown, West
rginia.

Building and Burning the Lime Stack

The lime stack is intended for use where the more permanent
aw kiln cannot be constructed to advantage, or where only a
nited supply is desired for a year or two.

To build a lime stack, first lay down a rectangular foundation
logs and poles (up to fifteen inches in diameter) in regular order
de by side large enough to hold the stone and coal. When fin-
hed the stack should be not more than eight feet high nor more
an twenty feet wide. If a larger stack is desired, increase the
ngth. A few feet in from each end or side (depending on direc-
on in which logs are placed) leave a couple of the logs a little farther
art than the others and fill in with finer wood and kindling. These
aces are to serve as flues to carry the fire through the stack. At
e ends of each flue add more kindling and cover each by setting
o stones on edge with a third over the top. This covering is to
event dirt and coal from falling down and closing the ends of the
ues where the fire is to be started. Place over this foundation
enty of dry material, such as fence rails, chips, corn cobs, and
ush. For general arrangement of the foundation, see Figure 10.

Next put on a layer of limestone about three inches deep and
ade up of pieces not more than three inches in diameter. This
yer should come within a few inches of the outside of the wooden
undation. Cover the stone with just enough coal to hide it, fine
al being preferred. Continue alternating layers of stone with layers
coal as follows:

ourses	Thickness of Stone Layer in Inches	Diameter of Stone in Inches
First	3	3
Second	5	3
Third	8	4
Fourth	10	4
Fifth	12	6
Sixth	12	7

Fertilizer and Lime Plots on One of the Agricultural Experim
Station Farms, Morgantown, West Virginia

Fig. 6.—No Treatment; 100 Pounds Hay per Acre.

Fig. 7.—Lime Only; 750 Pound Hay per Acre.

Any additional layers should be the same thickness as the la As the stones become larger toward the top a greater proporti of coal will be required to cover them; therefore, the thickness the layer of coal should be reduced so as to have the same ratio coal to stone as in the first layer. The area of each succeeding lay on the stack should also be reduced and no large stones should b used near the outside. Finally, a thin layer of coal should be p over the outside, and the stack should be banked with from fi to nine inches of earth from the ground up one-third to one-half t height of the stack. Care should be used not to close or destr the stone projections of the flues.

Size of Stack to Build

The size of the stack will, of course, be determined largely b the amount of lime desired. One long ton of coal used in a larg

Fig. 8.—Lime and Fertilizer; 5800 Pounds Hay per Acre.

Fig. 9.—Lime and Manure; 7400 Pounds Hay per Acre.

stack will produce about three and a half tons or ninety bushels of stone of "caustic" lime. In a small stack forty bushels of coal may be required to produce a hundred bushels of lime. Therefore, if it is desired to produce fifty tons of lime about fifteen long tons of coal will be needed. In volume, a stack of this size, will require about 420 bushels (165 wheelbarrowfuls of 200 pounds each) of coal and 1470 bushels (600 wheelbarrowfuls of 300 pounds each) of limestone. A stack with a foundation 16 by 20 feet will produce 500 bushels. From these figures one may readily determine the size of the stack desired.

Burning the Stack

When ready to fire, pour a liberal quantity of kerosene on the kindling in the two flues on the windward side and set on fire. As soon as the fire is well started close the unused flues at the opposite end.

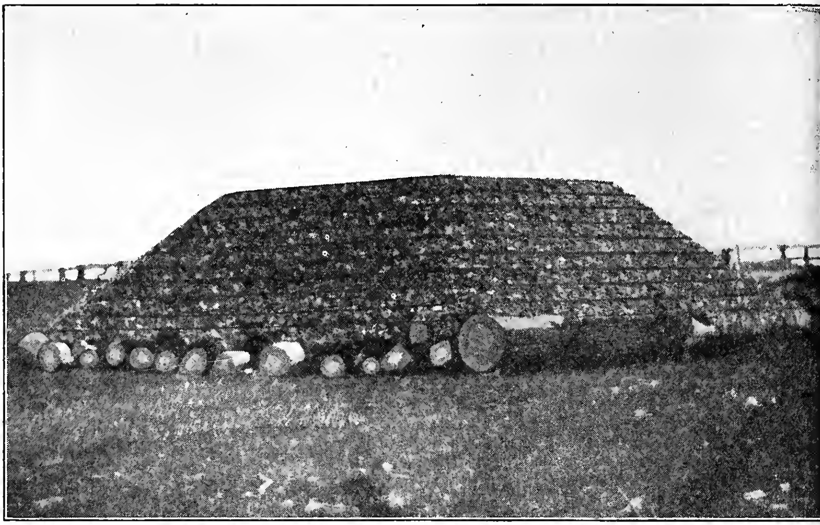

Fig. 10.—The Lime Stack Ready for the Covering of Fine Coal.

Loose soil should now be made in readiness along the sides o the stack and as the fire approaches the uncovered portion near th top of the stack throw on more dirt, keeping the covering just ahea of the fire until the entire stack is covered. Also watch for an promptly cover any cracks resulting from settling. If the stac burns too rapidly bank it with more dirt.

After the stack has finished burning and the lime is cool enoug to haul, it may be taken to the field and placed in small piles t slake. After slaking it is ready to spread. A bushel of this ston lime weighs eighty pounds and from this the rate of distributio can readily be determined. A couple of shovelfuls of dirt thrown o each pile when put in the field will absorb much lime dust and mak spreading more agreeable. If more convenient, the lime may b water-slaked in the stack, and then spread directly when hauled t the field. This is particularly desirable in case a spreader is to b used. Proper slaking will require from four to eight barrels o water depending on the size of the stack. This should be poured in openings made in the top of the stack.

Fig. 11.—A Type of Wood Burning Lime Kiln now Largely Replaced by e Stack.*

Construction of the Lime Kiln

The permanent lime kiln is particularly adapted to sections that ive limestone and coal convenient and where it is desired to proice a considerable quantity of lime each year for a period of three more years. The initial cost of the permanent kiln is greater than iat of the lime stack but production is easier and cheaper than with ie stack.

To construct such a kiln in which either coal or coke alone or ther of these in combination with wood are to be used as fuel, elect a hillside as near the fuel and limestone supply as possible. he ideal location is where the stone is above the site selected and in be worked down hill to the kiln and the fuel can easily be gotten the kiln (see Figure 12). Dig back nearly horizontally (a slope one inch to the foot makes it much easier to remove lime when rawing) into the hill so far as is necessary to get a vertical distance the surface of about 15 feet. If this is impossible filling above the kiln later will give the same advantages. The excavaon should be about eight feet wide from the top down to a distance

*For more complete description of this type of kiln see Extension Circular No. 174, ollege of Agriculture, Lexington, Ky.

of seven feet from the bottom (see Figure 13, line AA). From th point down it may be gradually narrowed in from the back and re half of each side till a width of about four feet remains at the bas as shown in Figure 13, line BB. A circular hopper (the kiln prope resembling an inverted jug is to be constructed in this excavatio the back corners, therefore, need not be dug out.

Within the limits of the base as shown in Figure 13, line B dig a ditch six inches deep at the rear of the excavation and twel inches deep at the front and in this begin a wall (see Figure 14 The depth is greater in front to avoid the effect of frost. Contin the ditch and wall across the front and back toward the hill as show in Figure 14. The thickness of the wall and other dimensions w be determined somewhat by the material used and size and locati of kiln, but for greatest convenience, the enclosed area as shown Figure 14, should not be less than, and approximately as follow A to B and C to D each = 24 inches; A to C and B to D ea =36 inches; C to E and D to F each=8 inches; E to G and F to each=78 inches; G to H=60 inches; G to I and H to K each= inches; and I to S and K to M are determined by the grade of t hill. When this wall has been brought on a level with bottom of t main excavation, place in the back of this V shaped opening a sloping toward the front a piece of boiler plate so as to rest on t ground and lap over the edge of the wall at the rear and both sid and reach forward four feet or more. Continue the wall on top this boiler plate twenty-four inches where heavy stones or iron ba should be placed across the opening from C to D (see Figu 12). Build the wall twelve inches higher but this time acro the bars at C-D leaving the section C-A-B-D untouched. No drop back toward the front of the opening twelve inches fro where the first bars were placed and lay others in the same mann (see Figure 12). Again add to the wall but build only to the seco set of bars and then across these. Continue this building and dro ping back, making the distance a little greater each time until a la set of bars are placed across the opening about six to seven feet fro the ground at G-H. Then build across these and continue the wa to the height of the kiln as shown in Figures 12 and 14. It will found advisable in most cases to build the interior, or hopper, of t kiln at the same time as the outside retaining wall. To do this beg at the twenty-four-inch square opening left when the first bar w placed across the opening through which lime is removed and bui a hopper shaped like an inverted jug, the greatest bulge of whi

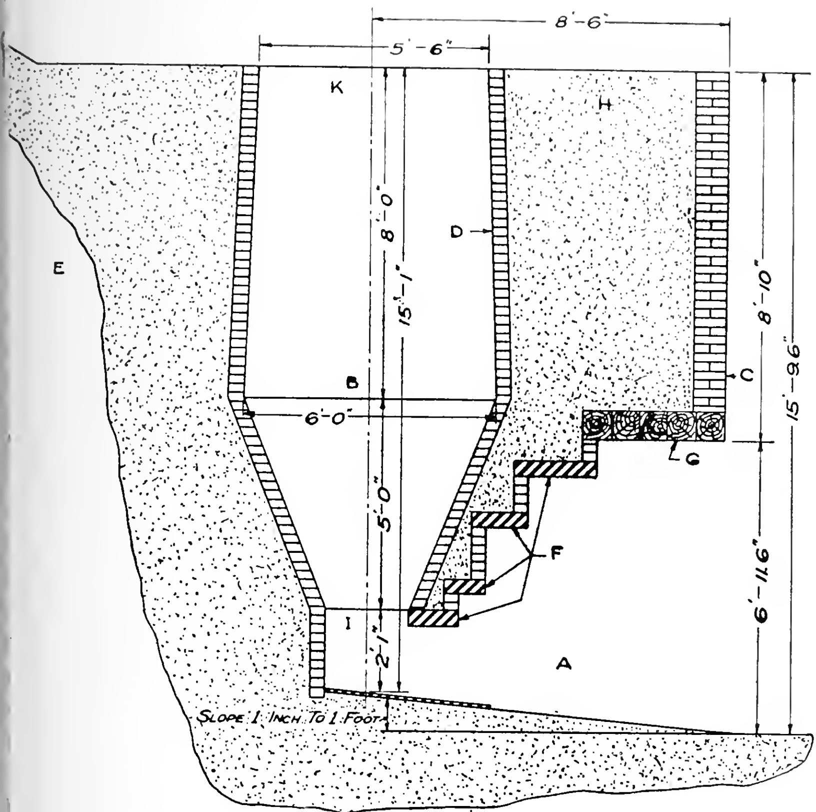

Fig. 12.—Vertical Section of Kiln.

A. Passage to mouth of hopper through which lime is removed.
B. Hopper or kiln proper.
C. Front retaining wall of any type of stone.
D. Fire brick or sand stone lining to kiln.
E. Hill serving as back retaining wall.
F. Iron bars supporting ceiling over passageway.
G. Wood beams serving same purpose.
H. Dirt filling between kiln and front retaining wall.
I. Mouth of kiln through which lime is removed.
K. Opening at top through which stone and fuel is fed.

l come about seven feet from the boiler plate (see Figure 12). The
pper should be about five and a half to six feet in diameter at the
atest bulge, five to five and a half feet at the top, and have an open-
twenty-four inches square at the bottom. As the walls of the kiln
built up dirt should be filled in and packed hard between the

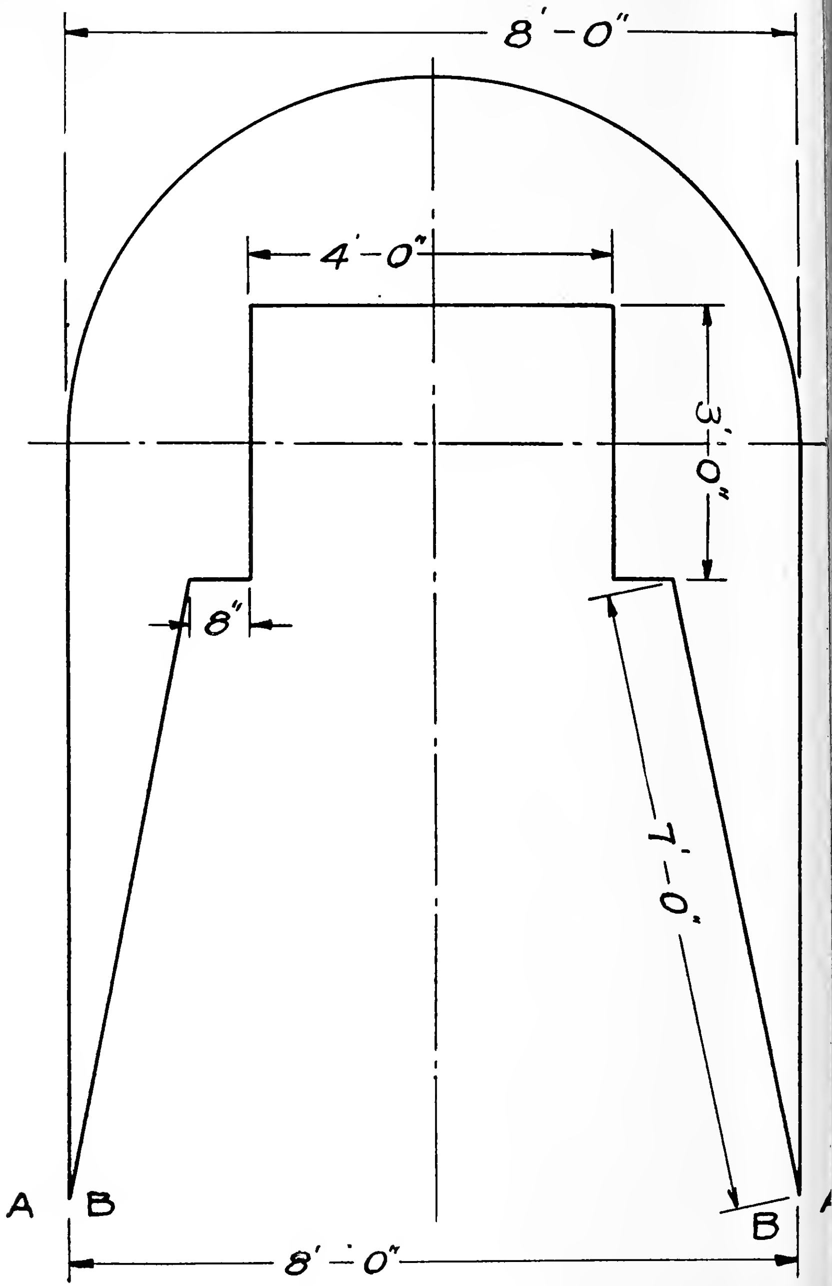

Fig. 13.—View of Excavation. Line AA Shows Outline of Excavati
from Surface Down to Seven Feet from Base. Line BB Shows Outline of Ba

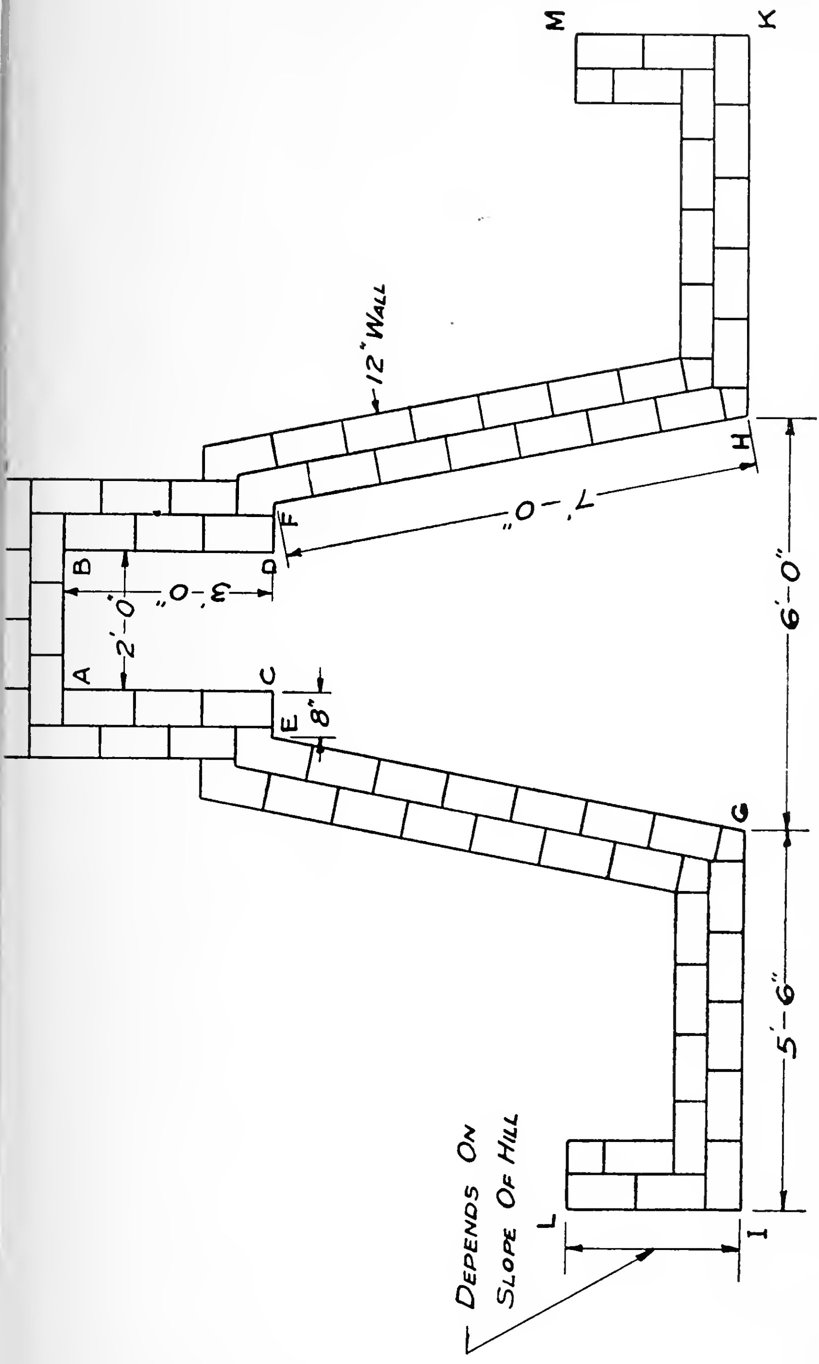

Fig. 14.—Foundation Wall of Kiln Constructed in and About Excavation Shown in Figure 13.

hopper and outside retaining wall. When these have been brought to the desired height the kiln is completed. The greater the height of the kiln the greater will be its daily capacity. Variations from the above dimensions will make no material difference if the opening at the base is kept large enough and the dimensions are kept in proportion.

A cheaper and more temporary kiln can be constructed after this same plan by substituting logs for stones in the front and side wall, as shown in Figure 15. The kilns shown in this figure are not over ten feet high.

Sandstone or fire brick must be used in the hopper of the kiln and about the mouth, since limestone would soon burn out. For this purpose about 4000 standard fire brick for a nine-inch lining will be required. The standard size of a fire brick is 2½ by 4½ by 9 inches. About 800 pounds of fire clay to each 1000 bricks will also be required.

Burning the Kiln

The permanent kiln constructed, the next step is to prepare the fuel and stone and fire it.

In starting the kiln observe the following steps.

1.—Put a generous supply of kindling in the bottom of the kiln.

2.—On top of this place six feet of wood (about one cord).

3.—Put on a layer of six inches of limestone broken into pieces the size of a quart cup or smaller.

4.—Add just coal enough to cover the stone.

5.—Put on another layer of ten inches of stone.

6.—Add coal as before.

7.—Put on twelve inches of stone.

8.—Add coal as before and continue to alternate as in steps 7 and 8 until the kiln is full. Fire the kiln and keep it full by continuing to alternate as in steps 7 and 8.

In a kiln the size here described 1¼ to 1½ tons of coal will turn out 100 bushels of stone lime (quicklime) equivalent to about 6¾ tons of hydrated lime. One ton of coke will take the place of 1½ to 1¾ tons of coal.

Wood may be used to advantage with the coal or coke but cannot be used alone in this type of kiln since wood burns too rapidly. In a kiln of this size, lime should be drawn every three of four

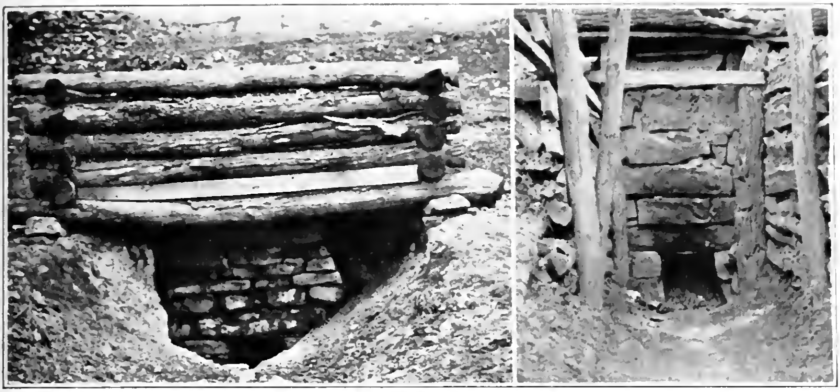

Fig. 15.—Temporary Lime Kilns in Use in Greenbrier County, West Virginia.

hours to get the greatest production. No evil effects other than loss of time will result, however, by less frequent drawings. If it is not desirable to keep a man at the kiln over night, or over Sunday, fill the hopper well up and shut off draft by closing the opening at the base.

In case the stone comes down unburned when drawing, cut off some of the draft and burn slower. If this does not correct the trouble add more fuel. In case over burned stone comes down increase the draft, and if necessary, reduce the fuel. When through burning empty the kiln or the slaking lime will burst it.

The Construction and Burning of Kilns When Wood Is Used as Fuel

There are several types of kilns in which wood can be used as fuel. Some of these wood kilns are modifications of the form just described for coal. Two fire boxes are built in from opposite sides of the kiln along the slope of the hill and open into the hopper just below its largest diameter. These fire boxes should be about two and a half feet wide by three feet high with an opening into the kiln of the same size. A grate should be fitted into the bottom of these boxes so that the ashes will drop through and can be removed. This also gives much better draft and heat. The wood kiln, however, is not advisable or practicable in West Virginia except in rare cases.

SUMMARY

The analyses of four thousand soil samples from practically all sections of the state indicates that 95 per cent of the farm soils of West Virginia need lime.

Lime may be expected to give returns of four dollars or more for each dollar invested in it when used on land where needed, and in connection with good cropping and fertilizer practice. Lime and acid phosphate applied as a top dressing to pastures may be expected to yield excellent profits.

In some sections it is cheaper to buy material than to manufacture it at home; in others, roads, freight, and distance to haul make home manufacture of liming material advisable.

The community and custom pulverizers are giving satisfaction in most cases where in use.

Where only a small amount of lime is needed and there is available both limestone and fuel the lime stack is best suited to the need.

Where considerable lime is needed each year and plenty of fuel and limestone are available the permanent kiln is better suited.

Little or no difference should be expected in the returns from the use of chemically equivalent amounts of different forms of lime.

Lime does not take the place of fertilizer.

Generally the best time to apply lime is when there is time to do the work and roads and fields are in condition to haul over.

The best rate of application is generally two tons of ground limestone or its equivalent per acre for the first application and one ton per acre every six years thereafter. Such applications should be based upon the results of soil tests.

Greatest profits can be expected from the use of lime only when it is used in connection with a good crop rotation and fertilizing plan.